Health Consultation

Volatile Organic Compounds in Residential Drinking Water Supply Wells near Forest Napavine Road and Jackson Highway

Lewis County, Washington

October 10, 2000

Prepared by
Washington State Department of Health
under a cooperative agreement with the
Agency for Toxic Substances and Disease Registry

Washington State Department of Health

Foreword

The Washington State Department of Health (DOH) has prepared this health consultation in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is part of the U.S. Department of Health and Human Services and is the principal federal public health agency responsible for health issues related to hazardous waste. This health consultation was prepared in accordance with methodologies and guidelines developed by ATSDR.

The purpose of this health consultation is to identify and prevent harmful human health effects resulting from exposure to hazardous substances in the environment. The health consultation allows DOH to respond quickly to a request from concerned residents for health information on hazardous substances. It provides advice on specific public health issues. DOH evaluates sampling data collected from a hazardous waste site, determines whether exposures have occurred or could occur, reports any potential harmful effects, and recommends actions to protect public health.

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Glossary

Agency for Toxic Substances and Disease Registry
The principal federal public health agency involved with hazardous waste issues, responsible for preventing or reducing the harmful effects of exposure to hazardous substances on human health and quality of life. ATSDR is part of the U.S. Department of Health and Human Services.

Cancer Risk Evaluation Guide (CREG)
The concentration of a chemical in air, water, or soil (or other environmental media), that is expected to cause no more than one additional cancer in a million persons exposed over a lifetime. The CREG is a comparison value used to select contaminants of potential health concern.

Cancer slope factor
A plausible upperbound estimate made by EPA of the probability of a response per unit intake of a chemical over a lifetime. The slope factor is used to estimate an upperbound probability of an individual developing cancer as a result of a lifetime of exposure to a particular level of a potential carcinogen.

Carcinogen
Any substance that can cause or contribute to the production of cancer.

Chronic
Occurring over a long period of time (more than 1 year).

Comparison Value
A concentration of a chemical used to select contaminants of concern which require further evaluation in the Health Assessment process. The terms comparison value and screening level are often used synonymously.

Contaminant
Any substance or material that enters a system (the environment, human body, food, etc.) where it is not normally found.

Dose
The amount of a substance to which a person is exposed; usually expressed as concentration of chemical per unit body weight.

Environmental Media Evaluation Guide (EMEG)
A concentration in air, soil, or water (or other environmental media), below which adverse non-cancer health effects are not expected to occur. Separate EMEGs can be derived to account for acute, intermediate, or chronic exposure durations.

Exposure

Contact with a chemical by ingesting, inhaling, or by direct contact (such as through the skin or eyes). Exposure may be short-term (acute) or long-term (chronic).

Exposure Pathway
An exposure pathway is the process by which an individual is exposed to contaminants that originate from a source of contamination. It consists of five elements: 1) Source of contamination, 2) Environmental Media/Transport, 3) Point of Exposure, 4) Route of Exposure, 5) Receptor Population.

Groundwater
Water found underground that fills pores between materials such as sand, soil, or gravel. In aquifers, groundwater often occurs in quantities where it can be used for drinking water, irrigation, and other purposes.

Lowest Observed Adverse Effect Level (LOAEL)
LOAELs have been classified into "less serious" or "serious" effects. In dose-response experiments, the lowest exposure level at which there are statistically or biologically significant increases in the frequency or severity of adverse effects between the exposed population and its appropriate control.

MCL
Maximum Contaminant Level. A drinking water regulation established by the Safe Drinking Water Act. It is the maximum permissible concentration of a contaminant in water that is delivered to the free-flowing outlet of the ultimate user of a public water system. MCLs are enforceable standards.

MRL
ATSDR's Minimal Risk Level. The dose of a substance below which adverse non cancer health effects are not expected to occur. MRLs are derived when reliable and sufficient data exist to identify the target organ(s) of effect or the most sensitive health effect(s) for a specific duration via a given route of exposure. MRLs can be derived for acute, intermediate, and chronic duration exposures by the inhalation and oral routes.

Media
Soil, water, air, plants, animals, or any other part of the environment that can contain contaminants.

Model Toxics Control Act (MTCA)
The hazardous waste cleanup law for Washington State.

Monitoring Wells
Wells developed to collect groundwater samples for the purpose of physical, chemical, or

biological analysis to determine the amounts, types, and distribution of contaminants.

No Apparent Public Health Hazard
A conclusion category used when human exposure to contaminated media is occurring, or has occurred in the past, but the exposure is below a level of health hazard.

No Observed Adverse Effect Level (NOAEL)
The dose of a chemical at which there are no statistically or biologically significant increases in the frequency or severity of adverse effects observed between the exposed population and its appropriate control. Effects may be observed at this dose, but were judged not to be "adverse".

Oral Reference Dose (RfD)
RfDs are levels of chemical exposure, derived by the Environmental Protection Agency, below which non cancer health effects are not expected. An RfD is derived by dividing a LOAEL or NOAEL by "safety factors" to account for uncertainty and to provide added health protection.

RMEG
ATSDR's Reference Dose Media Evaluation Guide. A concentration in air, soil, or water (or other environmental media), which is derived from EPA's RfD, and below which adverse non- cancer health effects are not expected to occur. RMEGs account only for chronic exposure.

Risk
In risk assessment, the probability that something will cause injury, combined with the potential severity of that injury.

Volatile Organic Compound (VOC)
An organic (carbon-containing) compound that evaporates (volatilizes) easily at room temperature. Many commonly used cleaning solvents contain VOCs.

Background and Statement of Issues

This Health Consultation was prepared at the request of Lewis County to evaluate the health implications from past exposure to contaminants detected in two residential wells. In June 1998, during routine testing of water, Lewis County Environmental Services (Lewis County) discovered elevated levels of volatile organic compounds (VOCs) in the Lewis County Maintenance Shop (Shop) well water. The Shop and residences are located in a semi-rural area, near the intersection of Forest Napavine Road East and Jackson Highway, approximately 5 miles southwest of Chehalis, in Lewis County (Figure 1). The results of the Shop well water sample was reported to the Washington State Department of Health (DOH) after laboratory analysis was completed. Follow-up testing of water from the Shop drinking water well and seven nearby domestic wells was conducted by the DOH Division of Drinking Water on June 24 and July 22, 1998. Test results confirmed the presence of elevated levels of VOCs in the Shop well, and low levels of several VOCs in three nearby wells. Because results indicated that the three nearby wells, servicing the Grange, the Tietzel's residence, and the Douglas Christmas Tree Farm had been impacted, DOH recommended follow-up testing.[1] With Ecology oversight, Lewis County is conducting a Remedial Investigation to determine the source and extent of contamination.[2] In the fall of 1999, DOH prepared a Health Consultation which evaluated the health implications associated with the VOC detections in the Shop's well water.[1]

Because of the potential for migration of VOCs from the Shop property, DOH and Lewis County tested over 20 area residential wells since April 2000.[3] Periodic testing will continue as part of the ongoing groundwater investigation.[2, 4] Some of the wells tested were found to contain low or trace levels of VOCs. Levels of some VOCs detected in one of the tested wells (a newly constructed well), which serves two residences on Jackson Highway, exceeded safe drinking water standards.[5] An open, hand-dug well also serviced one of these residences for many years prior to installation of the newer well.[4] The older well was tested for VOCs once in July 1998, and revealed only a trace level of trichloroethylene (TCE), a VOC.[6] The source(s) of the residential well contamination has not been determined, but the County Maintenance Shop, located approximately a quarter mile to the south, is being evaluated as a possible source. As a result of the elevated VOC detections in the newer well, Lewis County advised the residents who access the well to use bottled water for drinking and cooking, to limit the amount of time they spend in the shower, and to ventilate the bathroom while showering.[7] Lewis County is currently supplying bottled drinking water to these residents and is in the process of evaluating the feasibility of a more permanent, safe domestic water supply for these residences, such as hookup to the Chehalis municipal water system.[4]

A total of six VOCs were detected in the new well during the April 25, 2000, sampling event, and one VOC was detected in the old well in a July 1998 sampling event.[5, 6] *Concentrations of three VOCs during the April 2000 sampling event exceeded health comparison values, and were further evaluated in the Health Consultation to evaluate the potential for adverse health effects.* The other VOCs detected were at levels below health comparison values and will not be discussed further in the Health Consultation (Table 1). In estimating past exposure to VOCs in the two residential wells, it was assumed that the residents were exposed for 30 years to TCE detected in the older well, and for one-half year to the VOCs detected in the newer well (the newer well has only been

used since the fall of 1999). Since April 2000, Lewis County has provided bottled water for the residents using this well.[4] As a result, the only current exposure to the VOCs would be from incidental inhalation of vapors during showering and cooking activities.

Contaminant concentrations and health comparison values are presented in Table 1. Estimated cancer and non-cancer health risks are presented in Table 2. Exposure assumptions used in estimating health risks are presented in Appendix A.

Table 1
Contaminant Detections/Concentrations & Health Comparison Values[8]

Residential Well
(April 25, 2000, Sampling Results)

Chemical/Analyte	Concentration (µg/l)	Carcinogenic Comparison Value (µg/l)	Non-carcinogenic Comparison Value (µg/l)
1,1-Dichloroethylene	*1.5*	0.06 (CREG)	300 (adult chronic EMEG) 90 (child chronic EMEG)
1,1,1-Trichloroethane	4.3	NA	200 (MCL/LTHA) 40,000 (CLHA)
Trichloroethylene	*0.5/26*	5 (MCL)	
Cis-1,2 Dichloroethylene	3.3	NA	3,000 (child Int. EMEG/CLHA) 10,000 (adult Int. EMEG) 70 (MCL/LTHA)
Tetrachloroethylene	*7.8*	NA	100 (child RMEG) 400 (adult RMEG) 5 (MCL)
1,1-Dichloroethane	1.1	NA	800 (MTCA B)

µg/l = micrograms of chemical per liter of water (equals one part per billion)
CREG = ATSDR's Cancer Risk Evaluation Guide
RMEG = ATSDR's Reference Dose Media Evaluation Guide
LTHA - EPA's Lifetime Health Advisory for Drinking Water
MTCA B = Washington State Department of Ecology Model Toxics Control Act Cleanup Regulation, Method B groundwater cleanup level
MCL = Federal Safe Drinking Water Act Maximum Contaminant Level
Int. EMEG = ATSDR's Intermediate duration Environmental Media Evaluation Guide
CLHA = Child Longer Term Health Advisory (EPA)
NA = Not available
Italicized and shaded cells = chemical which exceed one or more health comparison values and were further evaluated in the Health Consultation

Table 2
Cancer and Non-cancer Risks

Chemical/Analyte	Exposure Frequency (days/week)	Exposure Duration (years)	Hazard Quotient ★ (non-cancer)	Increased Ca
1,1-Dichloroethylene (CPF = 0.6)	7	0.5	0.006 (adult) 0.02 (child)	2 x 10^{-7} (a 7 x 10^{-7} (c
1,1,1-Trichloroethane	7	0.5		
Trichloroethylene (former CPF = 0.011)	7 7 7	0.5 30	0.0005 (adult) 0.002 (child) 0.00002 (adult) 0.0001 (child to adult)	4 x 10^{-8} (a 2 x 10^{-7} (c 8 x 10^{-8} (a 1 x 10^{-7} (child
cis-1,2 Dichloroethylene	7	0.5	0.0004 (adult) 0.001 (child)	
Tetrachloroethylene (former CPF = 0.051)	7	0.5	0.03 (adult) 0.09 (child)	1 x 10^{-7} (a 3 x 10^{-7} (c
1,1-Dichloroethane	7	0.5		
TOTAL HAZARD QUOTIENT & INCREASED CANCER RISK			**Adult Total = 0.04** **Child Total = 0.1**	**Adult Total ~** **Child Total ~**

★ Hazard Quotient less than 1 indicates that non cancer health risks are unlikely to result from exposure at the chemical concentrations evaluated
IARC = International Agency for Research on Cancer
3 = Not Classifiable
2A = Probably Carcinogenic to Humans (limited human evidence; sufficient animal studies)

EPA Class C = Environmental Protection Agency Possible Human Carcinogen (no human studies, limited animal studies)
EPA Class D = Not classifiable as to human carcinogenicity

CPF = Cancer Potency Factor

Discussion

ATSDR, as well as other agencies, has developed health-based comparison values for chemicals in various environmental media, including water. These values specify the concentration at or below which carcinogenic and/or noncarcinogenic health effects are not likely to result following exposure. Contaminant concentrations exceeding these values do not *necessarily* pose a health threat, but have been further evaluated to determine the potential for health effects. Since some VOCs in one of the residential wells evaluated exceeded one or more comparison values, they were further evaluated to determine whether health effects are likely.[8] Except for incidental exposures through volatilization of chemicals during certain types of activities (i.e., hand washing, cleaning, or cooking), contaminant exposures were effectively eliminated since bottled water was provided in April 2000.

Evaluating non-cancer risk

To evaluate potential noncancer health effects, estimated exposure doses were compared to EPA's Oral Reference Dose (RfD) or ATSDR's Minimal Risk Level (MRL). RfDs and MRLs are levels of chemical exposure below which non cancer health effects are not expected. RfDs and MRLs are derived from toxic effect levels obtained from human and laboratory animal studies. The toxic effect levels are expressed as either the lowest observed adverse effect level (LOAEL) or the no-observed adverse effect level (NOAEL). In human or animal studies, the LOAEL is the lowest dose at which an adverse effect is seen, while the NOAEL is the highest dose that did not result in any adverse health effects.

To account for uncertainty (i.e., intraspecies variability, interspecies variability, and extrapolation of a subchronic effect level to its chronic equivalent), the toxic effect levels are divided by safety factors (typically from 100 to 1,000) to provide the more protective RfD or MRL. If a dose exceeds the RfD or MRL, the *potential* exists for adverse health effects. Thus, a dose only slightly exceeding the RfD or MRL is usually still well below the toxic effect level. The higher the estimated dose is above the RfD or MRL, the closer it will be to the toxic effect level.

RfDs and MRLs

Oral reference doses (RfDs) and minimal risk levels (MRLs) are levels of daily exposure to chemicals below which non-cancer health effects are not expected. MRLs are set by ATSDR for acute, intermediate, and chronic exposure. EPA sets RfDs based on chronic exposure only. An MRL or RfD is derived by dividing a LOAEL or NOAEL by "safety factors" to account for uncertainty and provide added health protection.

Evaluating cancer risk

For screening of chemicals known or expected to cause cancer, it is assumed that no "safe" level exists, and EPA cancer slope factors are used to calculate an "estimated" increased cancer risk. An exposure which results in an estimated increased cancer risk of one additional cancer in a population of one million persons exposed for 30 years, averaged over a 70-year lifetime, is considered an acceptable risk and is used as the comparison value. In a population of one-million men in the United States, about one-third (333,000) would be expected to develop cancer from all causes in their lifetime. For U.S. women, the figure is about one-fifth (200,000).[9] The estimated increased cancer risk means that if those 1 million men are exposed for 30 years to this level of the chemical, 333,001 would be expected to develop cancer. For the 1 million women exposed, 200,001 would be expected to develop cancer. Contaminants which exceeded a cancer

or non-cancer comparison value are discussed below.

Cancer Risk

Cancer risk estimates do not reach zero no matter how low the level of exposure to a carcinogen. Terms used to describe this risk are defined below as the number of additional cancers expected in a lifetime:

Term		# of Additional Cancers
moderate	is approximately equal to	1 in 1,000
low	is approximately equal to	1 in 10,000
very low	is approximately equal to	1 in 100,000
slight	is approximately equal to	1 in 1,000,000

1,1-Dichloroethylene

1,1-Dichloroethylene (1,1-DCE) is an industrial chemical not found naturally in the environment. It is used to make certain plastics and flame retardant coatings for fiber and carpet backing. 1,1-DCE is a colorless liquid that evaporates quickly at room temperature.[10] 1,1-DCE was detected during the April 2000 sampling event in the newly constructed well.

Non-cancer health effects

No information is available on human health effects from exposure to 1,1-DCE in drinking water. Animals exposed to high levels of 1,1-DCE developed liver and kidney disease. Birth defects did not occur in the newborn of female rats that drank 1,1-DCE.[10] The ATSDR chronic-duration oral Minimal Risk Level (MRL) is based on a Lowest Observed Adverse Effects Level (LOAEL) for liver effects in rats. The oral reference dose (RfD) is the same as the MRL, and is based on the same effects in rats.[11] *The estimated daily exposure dose for persons exposed to the detected concentration of 1,1-DCE in the residential drinking water well is from 50 to 160 times lower than the MRL and RfD, suggesting that non-cancer health effects are unlikely to result from exposure.*

Cancer effects

Based upon the results of limited animal studies, EPA has determined that 1,1-DCE is a Class C (possible human) carcinogen.[11] Evidence from epidemiological studies of workers exposed to 1,1-DCE is inconclusive. Several studies evaluated the possibility that 1,1-DCE may increase the risk of cancer in animals. One of these studies suggested that mice breathing 1,1-DCE for 1 year developed kidney cancer, but the particular type of mouse used may be especially sensitive to 1,1-DCE.[10] *The estimated increased cancer risk, assuming a six-month exposure to the detected concentration of 1,1-DCE is insignificant; from two additional cancers in a population of 10,000,000 persons exposed to seven additional cancers in a population of 10,000,000 persons exposed.*

Trichloroethylene

Trichloroethylene (TCE) is a nonflammable solvent that is often used in industry for metal cleaning. TCE is also found in many adhesives, paint removers, and spot removers.[12] It is a

colorless liquid that is odorless at low levels (below 100 ppm). TCE is one of the more common contaminants found in groundwater at hazardous waste sites.[12] It dissolves easily in water and can readily volatilize into the air. Exposures can occur not only by drinking the water, but also through dermal contact from dishwashing, cleaning, and bathing, and through inhalation of vapors during showering, cooking, and other domestic activities. TCE was detected in both residential wells that were evaluated.[5, 6] A trace amount was detected during a July 1998 sample collected from the abandoned dug well, and an elevated level was detected in a more recent sample collected from the new well (Table 1).

Non-cancer health effects

Exposure to high levels of TCE in the air can cause central nervous system effects such as dizziness and headaches. Dermal exposure to very high concentrations of TCE can cause skin rashes. Exposure to extremely high levels of TCE can cause coma and death. Chronic ingestion of low concentrations of TCE may cause liver and kidney damage, nervous system effects, impaired immune functions, lung and heart effects, and impaired fetal development in pregnant women. The applicability of these effects on humans is unclear as most of the health effects observed were from animal studies.[12] The data from human studies suggest an association between TCE exposure and developmental effects. These effects may include neural tube defects, heart malformations, oral clefts, low birth weight, and increased fetal death.[12] However, TCE exposure levels in these studies were not well defined, and there may have been exposure to multiple contaminants.

ATSDR has established an acute (less than or equal to 14 days exposure) oral MRL for TCE of 0.2 mg/kg/day, which is based on developmental effects observed in rats. In animal studies, the lowest amount of TCE that showed an adverse developmental health effect caused fetal heart abnormalities after a 3-month exposure period.[12] The combined estimated dose to residents exposed to TCE in both wells tested is from 500 to 2,000 times below the acute oral MRL, suggesting that noncancerous health effects are unlikely to result from exposure to the detected concentrations of TCE in the two residential wells tested.

Cancer effects

Until 1994, TCE was classified by EPA as a possible/probable human carcinogen. This classification has been rescinded, and TCE's potential cancer effects are currently under review. The National Toxicology Program (NTP) is also currently reviewing TCE. The International Agency for Research on Cancer (IARC) has classified TCE as a probable human carcinogen, based upon limited human evidence and sufficient evidence in animals.[11] Animal studies have shown that exposure to high levels of TCE may cause liver, lung, and testicular tumors. These studies should be viewed cautiously as other potentially carcinogenic compounds were present, in addition to the TCE.[11, 12] There is no conclusive evidence linking TCE to cancer in humans. Studies of human populations have attempted to characterize the effects of high levels of TCE on exposed workers. These studies were often limited by a small study size or the presence of

multiple chemicals, which can make the interpretation of health outcomes very difficult. Studies conducted in New Jersey and Massachusetts have linked TCE in drinking water to leukemias, specifically in children. The interpretation of these studies is very controversial as other contaminants were present in the drinking water. In addition, the exposure level and duration were not well defined, and the number of participants in the studies was small.[11, 12]

To estimate a cancer risk, the former oral slope factor was used. *The estimated increased cancer risk for persons exposed to TCE in the two residential wells evaluated is insignificant; approximately one additional cancer in a population of 10,000,000 persons exposed.*

Tetrachloroethylene (PCE)

PCE is a manufactured compound widely used for dry cleaning fabrics and as a metal degreaser. It is also used as an intermediate in the manufacturing of other products. PCE is one of the more common contaminants found at hazardous waste sites.[13] PCE was detected during the April 2000 sampling event in the newly constructed well. Cancer and non-cancer toxicity is discussed below.

Non-cancer effects

Liver and kidney damage and elevated liver weight/body weight ratios have been observed in laboratory animals after exposure to high doses of PCE. [11, 13]

Groups of 20 Sprague-Dawley rats of both sexes were administered doses much higher than the estimated exposure dose for residents exposed to PCE in evaluated in this Health Consultation. Males in the high-dose group and females in the two highest dose groups exhibited depressed body weights. Evidence of hepatotoxicity (increased liver and kidney weight/body weight ratios) were also observed at the higher doses.[13] Relative sensitivity to humans cannot be readily established, but the RfD is protective of the most mild effects observed in humans [diminished odor perception/decreased test scores in volunteers exposed to 20 mg/kg/day].[13]

The estimated daily exposure dose for persons exposed to PCE in the residential well evaluated is below the chronic oral RfD, suggesting that *adverse non-cancer health effects would not be expected.* The RfD is based on hepatotoxicity in mice and weight gain in rats.[13]

Cancer effects

An EPA workgroup is currently reassessing PCE carcinogenicity, and has therefore removed the oral slope factor.[11] EPA reviewed findings that suggest the weight-of-evidence for PCE is on a human carcinogen/probable human carcinogen continuum. Presently, the agency has not adopted a final position on the classification of human carcinogenicity for this chemical. The

International Agency for Research on Cancer (IARC) considers PCE a probable human

carcinogen, based on limited human evidence and sufficient evidence in animals.

Case-control studies were evaluated for possible associations between exposure to PCE and cancer effects in human populations. Although some of these studies indicate a possible association between exposure to PCE and various cancers, including bladder cancer, kidney cancer, and leukemia, the studies had limitations which precluded definitive conclusions.[11, 13]

Cancer has been reported in animals after oral exposure to PCE. Statistically significant increases in hepatocellular carcinomas occurred in the treated mice of both sexes. A cancer effect level (CEL) of 386 mg/kg/day was derived from a chronic mouse study. The cancer effects in this study were hepatocellular carcinomas.[13] Estimated exposures evaluated in this Health Consultation are well below this CEL. To estimate the cancer risk from exposure to PCE, the former oral slope factor was used. *The estimated increased cancer risk from exposure to the detected concentration of PCE is insignificant; approximately 3 additional cancers in a population of 10,000,000 persons exposed.*

Total cancer risk

Carcinogenic risks from exposure to the three contaminants of concern in the residential well evaluated were added to estimate the total increased cancer risk. **The total estimated increased lifetime cancer risk from exposure to the three contaminants of concern detected in the residential well is insignificant to slight; approximately one additional cancer in a population of 1,000,000 for the child exposure scenario, and approximately four additional cancers in a population of 10,000,000 for the adult exposure scenario**. The increased cancer risk is in addition to the expected cancer incidence rate for the general U.S. population noted previously.

Child Health: Reproductive and Developmental Effects

ATSDR's Child Health Initiative recognizes that the unique vulnerabilities of infants and children deserve special emphasis with regard to exposures to environmental contaminants. Infants, young children, and the unborn may be at greater risk than adults from exposure to particular contaminants. Exposure during key periods of growth and development may lead to malformation of organs (teratogenesis), disruption of function, and even premature death. In certain instances, maternal exposure, via the placenta, could adversely effect the fetus. After birth, children may receive greater exposures to environmental contaminants than adults. Children are often more likely to be exposed to contaminants from playing outdoors, ingesting food that has come into contact with hazardous substances, or breathing soil and dust. Pound for pound body weight, children drink more water, eat more food, and breathe more air than adults. For example, in the United States, children in the first 6 months of life drink 7 times as much water per pound as the average adult. The implication for environmental health is that, by virtue

of children's lower body weight, given the same exposures, they can receive significantly higher

relative contaminant doses than adults.[14]

DOH evaluated the likelihood of adverse reproductive or developmental effects as a result of exposure to the three contaminants of concern. Estimated exposures evaluated in this Health Consultation are well below levels at which developmental or reproductive health effects were observed in laboratory animal studies.

Conclusions

1. As the result of bottled water use, the health risk to residents exposed to the contaminated drinking water in the wells evaluated has been significantly reduced since the first use of bottled water in April 2000. Incidental exposure to VOCs through volatilization could still occur during showering, hand washing, and cooking activities, but the exposures would be minimal and would not be expected to result in adverse health effects.

2. A slight to insignificant increased cancer risk was estimated for persons exposed in the past through ingestion and inhalation of the detected levels of VOCs in the residential well evaluated.

3. Past exposure to the concentrations of contaminants detected in the residential wells evaluated would not be expected to result in non-cancerous health effects.

4. VOCs detections in the other area domestic wells were not evaluated in this Health Consultation. However, the levels in these other wells were considerably lower than levels detected in the well evaluated in this Health Consultation, and do not pose a health hazard.

5. Based on the available sampling information provided to DOH at the time of this Health Consultation, *no apparent public health hazard* existed, or currently exists, as a result of VOCs in the residential wells evaluated. The no apparent public health hazard category is used for sites where human exposure to contaminated media (i.e., water) is occurring or has occurred in the past, but the exposure is below a level of health hazard.

Recommendations and Public Health Action Plan

1. Residents should continue not to use water from the contaminated well until VOC concentrations are reduced, or until water treatment or an alternate water supply is provided.

Actions taken

Bottled drinking water has been provided to the residents since April 2000, when contaminants exceeding safe drinking water standards in their well water were first discovered.
2. To help assure a permanent, safe drinking water supply, the residences evaluated should connect to a regulated water source, such as the Chehalis municipal water system.. If such a

water source becomes available in this area, other at risk residences along Jackson Highway should be provided an opportunity to connect.

Actions planned

Connection to the Chehalis municipal water line is under consideration by Lewis County. Options include connecting to the Central Shop line or accessing lateral lines from an upgraded line along Jackson Highway.

3. The results of subsequent domestic well tests should be provided to DOH for evaluation.

Actions taken and planned

Lewis County has been providing DOH the results of domestic well tests as they become available.

4. Copies of this Health Consultation report should be provided to the residents whose wells were evaluated in this report, and to other area residents.

Actions planned

DOH is working closely with Lewis County to assure that copies of this Health Consultation and a Fact Sheet are mailed to the affected residents, and other area residents. Copies of the report and Fact Sheet will also be sent to Lewis County, Ecology, the local library, and other interested parties.

5. Area residents should be kept appraised of the domestic well investigation and well test findings, and of the ongoing Shop investigation.

Actions taken and planned

A public meeting was held on July 12 to inform residents of the area wide domestic well investigation findings to date. Lewis County, Ecology, Thurston County, and DOH have distributed fact sheets, memos, and letters to inform area residents about the ongoing domestic well investigation, of their individual well test results, of the Lewis County Shop investigation, and recommendations to protect their health.

6. DOH is available to provide additional assistance should health issues arise during the site investigation and cleanup.

Actions taken and planned

DOH has, and will continue, to work closely with Lewis County during the ongoing well

investigation.

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Appendix A- Exposure Assumptions [15]

Exposure duration
7 days/week
26 weeks
1,500 weeks (assumed for TCE exposure)

Ingestion rate
1.4 liters/day - Adult
1 liter - Older child
0.9 liters/day - Child

Body weight
72 kg - Adult
41 kg - Older child
15 kg - Child

Averaging time
70 years [25,550 days] (Carcinogenic)
0.5 year [180 days] (Noncarcinogenic)

Appendix B - Exposure Formulas

Exposure dose = [(C x IR x EF x ED)/BW x AT)]

Additional estimated lifetime cancer risk = Estimated exposure dose x OSF

where:
C = Concentration of contaminant (mg/L)
IR = Ingestion rate (liters of water/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (total # of years in exposure period)
BW = Body weight
AT = Averaging time (70 years x 365 days/year) for cancer
OSF = Oral cancer slope factor (an estimate of the excess upperbound lifetime probability of an individual developing cancer from an exposure)

References

1. Washington State Department of Health. Health Consultation: Volatile Organic Compounds in Well Water at the Lewis County Central Maintenance Shop, Chehalis, Lewis County, Washington. June 6, 2000.

2. Washington State Department of Ecology. Fact Sheet: Lewis County Central Shop - Chehalis. July 2000.

3. Lewis County Health Department. Memorandum: Potential Water Contamination. May 24, 2000.

4. Various personal communications with Sue Kennedy, Lewis County Public Health, April 2000 - present.

5. Washington State Public Health Laboratory. Volatile Organic Chemicals (VOCs) Analysis Report: Lewis County Residence. April 25, 2000.

6. Washington State Public Health Laboratory. Volatile Organic Chemicals (VOCs) Analysis Report: Lewis County residence. July 23, 1998.

7. Lewis County Health Department. Letter to Resident concerning results of April 25, 2000 domestic well VOC Analysis. June 5, 2000.

8. Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR Health-Based Comparison Values. U.S. Department of Health and Human Services; August 2000 update.

9. American Cancer Society. Facts and Figures, 1998 Cancer statistics.

10. Agency for Toxic Substances and Disease Registry (ATSDR). Toxicological Profile for 1,1-Dichloroethene, U.S. Department of Health and Human Services, Public Health Service, 1993 Update.

11. United States Environmental Protection Agency Integrated Risk Information System (IRIS), August 2000.

12. Agency for Toxic Substances and Disease Registry (ATSDR). Toxicological Profile for Trichloroethylene, U.S. Department of Health and Human Services, Public Health Service, 1997 Update.

13. Agency for Toxic Substances and Disease Registry (ATSDR). Toxicological Profile for Tetrachloroethylene, U.S. Department of Health and Human Services, Public Health Service, 1997 Update.

14. Agency for Toxic Substances and Disease Registry. Child Health Initiative, 1995.

15. U.S. Environmental Protection Agency Exposure Factors Handbook.

16. Lewis County Public Health. Memorandum to area residents re: Potential Groundwater Contamination. May 10, 2000.

Certification

This Evaluation of Volatile Organic Compounds in Residential Drinking Water Supply Wells near Forest Napavine Road and Jackson Highway Health Consultation was prepared by the Washington State Department of Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was begun.

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Debra Gable
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ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health consultation and occurs with the findings.

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Richard Gillig
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ATSDR